APPARATUS AND METHOD OF EQUALIZING CHANNEL IN DIGITAL BROADCASTING RECEIVER

CROSS REFERENCE TO RELATED APPLICATION

[01] This application claims the priority of Korean Patent Application No. 2002-79744, filed on 13 December 2002, in the Korean Intellectual Property Office, the disclosure of which is hereby incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[02] Apparatuses and methods consistent with the present invention relate to equalizing a channel in a digital broadcasting receiver, and more particularly, to an apparatus and a method of equalizing a channel in a digital broadcasting receiver, thereby preventing the performance of a digital broadcasting receiver from degrading by a ghost.

2. Description of the Related Art

[03] In general, digital broadcasting receivers use free space as their physical channels. Since the transmission path of a digital broadcasting signal changes with climate changes in the air, clouds, or troposphere, affects of the sun's changes, geographical features such as mountains, cliffs, or the ground, momentary movements of a mobile object in an outdoor environment or/and

an indoor environment, caused due to movements of cars or airplanes and the use of electronic appliances, the digital broadcasting signal is received by the digital broadcasting receiver through multiple transmission paths. As a result, ghosting occurs when the same digital broadcasting signal is received at different time.

[04] The digital broadcasting signal received by the digital broadcasting receiver is distorted due to a ghost. Thus, a screen is entirely or partially broken. In the worst-case scenario, images may not be displayed at all. As such, a conventional digital broadcasting receiver cancels the ghost using a channel equalizer to provide good performance even when the ghost occurs.

[05] The ghost can be classified into near ghosts, occurring subject to indoor environments, and long ghosts, occurring subject to outdoor environments. The near ghost occurs in a time range ranging from $-0.3\mu s$ to $+0.3\mu s$. The long ghosts occur in a time range of more than $+0.3\mu s$. Consequently, in indoor environments, the near ghosts have a level higher than the long ghosts.

[06] However, as shown in FIG. 1, the channel equalizer used in the conventional digital broadcasting receiver is configured to have a fixed equalization coverage area or a fixed equalization amplitude in the time range and a phase range, irrespective of possible levels of the long ghosts and the near ghosts. For example, the time range ranges from $-7.5\mu s$ to $+46\mu s$, and the phase range ranges from 0° to 359°.

[07] Accordingly, if a level of the near ghost does not fall within the equalization coverage area of the channel equalizer in the indoor environments, the channel equalizer cannot completely cancel the near ghost. Thus, the image may be broken or not displayed at all.

SUMMARY OF THE INVENTION

[08] The present invention provides an apparatus and a method which equalize a channel in a digital receiver in consideration of the ghost level of a received signal in a time range and a phase range.

[09] The present invention also provides an apparatus and a method which equalize a channel in a digital broadcasting receiver, which vary a channel equalization amplitude of a received broadcasting signal in consideration of the ghost level of the received broadcasting signal.

[10] The present invention also provides an apparatus and a method which equalize a channel in a digital broadcasting receiver, which completely cancel near ghosts in indoor environments.

[11] According to one aspect of the present invention, there is provided a channel equalization apparatus in a digital broadcast receiver. The apparatus comprises a filtering unit and an equalization amplitude control unit. The filtering unit filters a received broadcasting signal and outputs a channel equalization output signal. The equalization amplitude control unit controls an equalization coverage area of the received broadcasting signal by controlling a filtering coefficient of the filtering unit based on the level of ghost, if a ghost is included in the received broadcasting signal.

[12] According to another aspect of the present invention, there is provided a channel equalization method in a digital broadcast receiver. The method comprises detecting a ghost from a received broadcasting signal, detecting the level of the ghost, and controlling an equalization coverage area of the received broadcasting signal based on the detected level of the ghost and performing channel equalization for the received broadcasting signal.

BRIEF DESCRIPTION OF THE DRAWINGS

[13] The above and other aspects and advantages of the present invention will become more apparent by describing in detail an exemplary embodiment thereof with reference to the attached drawings in which:

[14] FIG. 1 shows the relationship between an equalization coverage area of a conventional channel equalizer and a near ghost occurring out of the range of the equalization coverage area;

[15] FIG. 2 is a functional block diagram of an apparatus which equalizes a channel in a digital broadcasting receiver, according to the present invention;

[16] FIG. 3 shows the relationship between an equalization coverage area and a ghost in channel equalization according to the present invention; and

[17] FIG. 4 is a flowchart describing a method of equalizing a channel in a digital broadcasting receiver, according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[18] The present invention will now be described more fully with reference to the accompanying drawings, in which an exemplary embodiment of the invention is shown.

[19] FIG. 2 is a functional block diagram of a channel equalization in a digital broadcasting receiver, according to the present invention. Referring to FIG. 2, the channel equalization includes a filtering unit 201 and an equalization amplitude control unit 202.

[20] The filtering unit 201 filters an input signal "input (n)" at a time "n" and outputs a channel equalization output signal "output (n)". The input signal "input (n)" is a digital broadcasting signal that has been converted by an analog-to-digital converter (ADC)(not shown) included in the digital broadcasting receiver.

[21] The equalization amplitude control unit 202 includes a ghost detector 202-1 and a coefficient determiner 202-2.

[22] Once the input signal "input (n)" is input, the ghost detector 202-1 determines whether a ghost is present in the input signal "input (n)". If a ghost is detected, the ghost detector 202-1 detects the level of the detected ghost and determines whether the detected ghost is a near ghost or a long ghost based on the time range and phase range of the detected ghost.

[23] That is, the ghost detector 202-1 identifies a main signal within the input signal "input (n)". The main signal corresponds to an actual broadcasting signal and "0μs" on the time axis of a graph of FIG. 3, which

shows an example of an equalization coverage area or an equalization amplitude. The ghost detector 202-1 detects the main signal using a time symbol.

[24] If the broadcasting signal is present in near time range and phase range based on the detected main signal, the ghost detector 202-1 recognizes that the ghost is present in the input signal "input (n)". If a DC level is detected in the time range and the phase range near the main signal, the ghost detector 202-1 recognizes that the broadcasting signal is present in the near time range and phase range based on the detected main signal.

[25] If the broadcasting signal is present in the time range and the phase range near the main signal and the time range ranges from -0.3μs to +0.3μs, the ghost detector 202-1 recognizes the detected ghost as a near ghost type. In contrast, if the broadcasting signal is present in a time range of more than +0.3μs or less than -0.3μs, the ghost detector 202-1 does not recognize the detected ghost as a near ghost type. Specially, if the detected ghost is present in a time range of more than +0.3μs, the ghost detector 202-1 recognizes the detected ghost as a long ghost type. The long ghost is a remote ghost based on the detected main signal.

[26] Thereafter, the ghost detector 202-1 detects the DC level of the detected ghost. The ghost detector 202-1 provides the DC level of the detected ghost and the type information of the detected ghost, e.g., an adjacent ghost or a remote ghost, to the coefficient determiner 202-2.

[27] The coefficient determiner 202-2 determines a filtering

coefficient which is provided to the filtering unit 201, based on the DC level of and the type of the detected ghost. If the detected ghost is a near ghost and the DC level does not fall within the equalization coverage area, the coefficient determiner 202-2 determines the filtering coefficient, so that the filtering unit 201 has an equalization amplitude to accept the DC level of the detected ghost and performs the channel equalization for the input (n).

[28] In this case, the coefficient determiner 202-2 determines a large coefficient to set a filtering large equalization amplitude. In other words, the coefficient determiner 202-2 determines the filtering coefficient to set a large filtering equalization coverage area, as shown in FIG. 3. The coefficient determiner 202-2 can determine the coefficient such that a newly set equalization coverage area, as shown in FIG. 3, is applied to the time range and phase range ranging from -0.3μs to +0.3μs. The coefficient determiner 202-2 can determine the filtering coefficient such that different equalization coverage areas are applied to the time range and phase range ranging from -0.3μs to +0.3μs by the detected ghost level.

[29] Additionally, the coefficient determiner 202-2 can determine the filtering coefficient such that the existing equalization coverage area is applied to the time range and the phase range outside the time range and the phase range where the near ghost is present, in a manner similar to FIG. 3. If the ghost level detected in time range and phase range outside the near ghost area is not included in the existing equalization coverage area, the coefficient determiner 202-2 determines the filtering coefficient greater than that of the

existing equalization coverage area, such that the equalization coverage area becomes greater than the existing equalization coverage area. A plurality of filtering coefficients available for filtering coefficient decision is previously stored in the coefficient determiner 202-2.

[30] The filtering unit 201 outputs the channel equalization output signal "output (n)" that is obtained by equalizing a channel of the input signal "input (n)" based on the filtering coefficient provided by the coefficient determiner 202-2.

[31] FIG. 4 is a flowchart showing a method of equalizing a channel in a digital broadcasting receiver, according to the present invention.

[32] After an input signal "input (n)" that is converted into a digital signal is received, a main signal is identified in the received signal in step 401. The main signal is an actual broadcasting signal based on a basis of time, as aforesaid with reference to FIG. 2.

[33] Then, in step 402, a ghost is searched for based on the detected main signal. In other words, as mentioned in the description of the ghost detector 202-1 of FIG. 2, a ghost is detected based on a basis of time.

[34] In step 403, it is determined whether a ghost has been found. If a ghost has been found, the DC level of the ghost is detected in step 404. In step 405, the channel equalization of the input signal "input (n)" is performed while controlling the equalization amplitude of the input signal "input (n)" based on the detected DC level of the ghost. In other words, if the existing equalization coverage area can cover the detected DC level of ghost, channel

equalization filtering for the input signal "input(n)" is performed using the filtering coefficient corresponding to the existing equalization coverage area. In contrast, if the existing equalization coverage area does not cover the detected DC level of the ghost, an equalization coverage area is newly set based on the detected DC level of the ghost. In other words, the filtering coefficient is determined to increase or extend the existing equalization coverage area. And then the channel equalization filtering for the input signal "input(n)" is performed.

[35] In FIG. 4, the equalization coverage area is controlled based on the detected DC level of the ghost, irrespective of the type of ghost, e.g., a near ghost or a long ghost. However, it is also possible to determine whether a near ghost is detected, and, if so, to set the time range ranging from -0.3μs to +0.3μs and the phase range as a new equalization coverage area, as shown in FIG. 3.

[36] As described above, it is possible to completely cancel a ghost included in the received broadcasting signal and prevent performance of a digital broadcast receiver from degrading due to a ghost, by setting the equalization amplitude or the equalization coverage area based on the DC level of a ghost included in the received broadcasting signal.

[37] In particular, since a near ghost caused by an indoor environment can be completely cancelled, performance of the digital broadcasting receiver in an indoor environment can be improved.

[38] While the present invention has been particularly shown and

described with reference to an exemplary embodiment thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims and their equivalents.